**Concept presentation**

**Physics (SPH3U)**

**Topic – Energy Transformations**

**Specific expectations covered:**

D3.1 Describe a variety of energy transfers and transformations, and explain them using the law of conservation of energy

D3.2 Explain the concepts of and interrelationships between energy, work, and power, and identify and describe their related units

D3.3 Explain the following concepts, giving examples of each, and identify their related units: *thermal energy, kinetic energy, gravitational potential energy, heat, specific heat capacity, specific latent heat, power,* and *efficiency*

**Background Information:**

### Distance and Displacement

Distance and displacement are two quantities that may seem to mean the same thing yet have distinctly different definitions and meanings.

* Distance is a [scalar quantity](http://www.physicsclassroom.com/class/1dkin/U1L1b.cfm) that refers to "how much ground an object has covered" during its motion.
* Displacement is a [vector quantity](http://www.physicsclassroom.com/class/1dkin/U1L1b.cfm) that refers to "how far out of place an object is"; it is the object's overall change in position.

### The Meaning of Force

A **force** is a push or pull upon an object resulting from the object's interaction with another object. Whenever there is an interaction between two objects, there is a force upon each of the objects. When the interaction ceases, the two objects no longer experience the force. Forces only exist as a result of an interaction.

**Newton's Three Laws of Motion**

1. Every object in a state of uniform motion tends to remain in that state of motion unless an external force is applied to it.
2. The relationship between an object's mass m, its acceleration a, and the applied force F is F = ma. Acceleration and force are vectors (as indicated by their symbols being displayed in slant bold font); in this law the direction of the force vector is the same as the direction of the acceleration vector.

III. For every action there is an equal and opposite reaction.

**Lesson Template:**

|  |  |  |
| --- | --- | --- |
| Steps to be followed | Teacher’s Activity | Student’s activity |
| **Warming up Activity** | Teacher may start by asking few brain storming questions related to daily life experiences.  For example: -You might head start to your job, sit at a computer, and type away at the keys. That's all we do here. Is that work? | Students try to think and answer by recalling the concepts learnt previously. |
| **Pre Content:**  Displacement, force and Newton’s laws of motion | Teacher will ask the students as to what they understand by the terms – displacement and force? | Students have an idea about  these terms from their lower  classes, they discuss in class  and also give some examples  by their previous knowledge. |

###### **Teaching Ideas and Strategies:**

1. Check students’ prior knowledge about the topic ‘force and displacement’ by brainstorming.

2. Make connections to real life situations.

3. Use computer animations to illustrate kinetic energy, potential energy and law of conservation of energy.

4. Before starting the simulation lab, review safety precautions for the safe use of internet.

5. An extension activity as a project to draw a flow map showing the flow of energy transformations in a car from starting vehicle to driving. The students should use 5 different types of energy.

**LESSON-1(Concept of work done)**

Teacher will explain the concept of work done.

Work is done when a [force](http://www.physics4kids.com/files/motion_force.html) that is applied to an object [moves](http://www.physics4kids.com/files/motion_velocity.html) that object in the direction of the force. Then, work done is calculated by multiplying the force by the amount of movement of an object

Mathematically: (W = F \* d).

Teacher will then describe the work done mathematically.

Students will be asked to do the quiz based on the topic taught.

**Quiz on the topic - work**

1. A teacher applies a force to a wall and becomes exhausted.

**Answer:** No. The wall is not displaced.

1. A book falls off a table and free falls to the ground.

**Answer:** Yes! There is a downward force (gravity) which acts on the book to displace it.

1. A waiter carries a tray full of meals above his head by one arm across the room.

**Answer:** No. There is an upward force, and there is a horizontal displacement but the force does not cause the displacement

1. A rocket accelerates through space.

**Answer:** Yes the expelled gas is the force (thrust) which accelerates the rocket through space.

The quiz is inquiry or thinking based; which will initiate the thought process of the students. If the concepts are well understood then the students will be able to apply and communicate.

**LESSON-2 (Energy and its various forms)**

Students study various forms of energy and explore the transformation of energy from one form into another. Activities include an online interactive study of how kinetic and potential energy forms are associated with motion and height, respectively.

Materials - Pictures of all of the given items - household batteries, candles, sun, radio, thermometers, toy cars, pinwheel, slinky, electric toaster and of nuclear power plants, free falling objects, windmills, and turbines. Another set of pictures of cell phones, microwave ovens, and hand-held devices.

Class setting - Initially, groups of three or four students work in together. All of the activities, including the demonstrations, can be done in a computer lab.

**Activity 1 (Forms of energy):**

1. Introduce the concept of energy by starting with the energy from the Sun (solar).
2. Divide the students into groups of four, and ask them to predict the possible forms of energy associated with the following demonstrations.
3. Demonstrate the following items one after the other: household batteries, candles, sun, radio, thermometers, toy cars, Slinky, pinwheel, and falling object.
4. Ask students to demonstrate forms of energy. Students will identify various forms of energy associated with each picture. For example, for a Slinky, students will identify that the stretching and contraction of the Slinky is associated with elastic energy.

**Activity 2 (Kinetic and potential energy):**

1. Download the [“Energy in a Roller Coaster Ride”](http://www.teachersdomain.org/resources/hew06/sci/phys/maf/rollercoaster/index.html) activity from the teacher’s domain site.
2. Introduce the concept of potential energy and kinetic energy as two types of energy. Demonstrate the activity to the class. The activity can be best demonstrated using the STEP mode.
3. Ask the student groups to report the kinetic and potential energy conversions in the activity, focusing on how the velocity of the roller coaster changes with its motion, and carefully noting the height of the roller coaster and velocity at each step. Students can make a table recording their observations and conclusions.

Roller coaster ride observations:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Step #** | **Step Height (cm)** | **Kinetic Energy (as fraction)** | **Potential Energy (as fraction)** | **Velocity of the Roller Coaster (m/sec)** |
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Questions and tips:

* + Review your work on the forms of energy. Where would the “types of energy” go?
  + What is kinetic energy?
  + What is potential energy?

Students will be asked to write the conclusion (difference between kinetic and potential energy):

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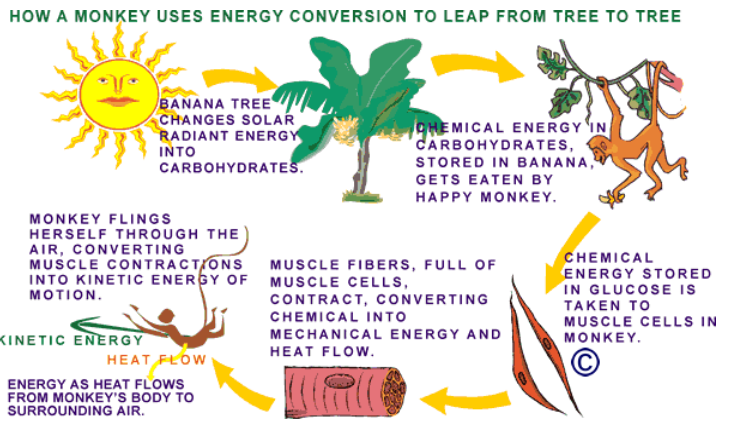
The following site can also be used to demonstrate kinetic, potential, and elastic energy forms: ["Potential and Kinetic Energy: Spool Racer"](http://www.teachersdomain.org/resources/phy03/sci/phys/mfe/zsplcar/index.html)

**LESSON 3 (Inter-conversion between energy forms):**

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| --- | --- | --- |
| **Extension Activity** | Teacher initiates an investigation by asking a guiding question.  Physics Investigation:  Draw a flow map showing the flow of energy transformations in a car from starting vehicle to driving. You should have 5 different types of energy. | Students analyze, discuss and reach conclusions to be shared in groups.  **Peer evaluation by taking feedbacks from other groups.** |

This lesson will complement the previous energy lesson nicely. Students were already familiar with the different forms of energy, so it would be easier to grasp the concept that energy could be converted from one form to another.

**One more activity to show inter-conversion of different forms of energy:**



**LESSON 4 (Law of conservation of energy):**

Teacher will explain the law of conservation of energy by showing the two videos and then discussing with the students about what was happening in the video and why?

<http://www.youtube.com/watch?v=jid7Nlzfet8>

<http://www.youtube.com/watch?feature=player_detailpage&v=51RCyBr_nGk>

Law of Conservation of Energy: - Energy can neither be created nor destroyed. Energy is always changing from one kind to another. The total energy of an object never changes.

**Teacher will focus**: So next time when you say that you don’t have the energy to do a particular work, I know that you are lying as the energy has only changed to some other form.

**Student difficulties and common misconceptions and the remedy:**

* Force = energy
* The presence of energy enables the body to exert force and hence equivalent amount of work is performed.
* Energy is only in living things
* Even non-living things have energy; fossil fuel is a simple example.
* Energy can be made, used and lost
* One form of energy gets converted in the other form, while performing work, but nothing gets lost if all the energy forms are considered together.

**Accommodation for special needs students and English language learners:**

Following accommodations will be made:

1. Providing additional time to complete tests or assignments
2. Permitting oral responses
3. Computer options and use of technology
4. Preferential sitting as outlined in their Individual Education Plans (IEPs). Gifted students can be challenged to complete extensions of topics covered in class to their everyday lives such as using green alternatives for chemicals extensive use of visual clues such as - graphic organizers, pre-teaching vocabulary, pre-viewing text books, peer tutoring, using a variety of learning resources such as bi-lingual dictionaries and simplified texts.

**Assessment & Evaluation:**

* **Quiz** on conservation of energy (T/I)
* **Simulation Lab – Kinetic and Potential Energy Labs (T/I)**
* **Project -** Rubric forthe project and oral presentations (Communication, Application)
* **Unit Test** (Knowledge/Understanding, Application, and Communication) with emphasis on Application of the concepts learned.

**Practical Applications and Societal Implications:**

* Wind power energy path
* Water power energy path

##### **Internet Sites:**

**Work-Energy simulation lab worksheet**

* <http://romano.physics.wisc.edu/winokur/fall2007/EnergySimulations.pdf>

**Build a coaster**

* <http://www.learner.org/interactives/parkphysics/>

**Concept simulation – Illustrates the relationship between kinetic and potential energy**

* [Potential and Kinetic Energy Experiment](http://www.visionlearning.com/library/flash_viewer.php?oid=1429&mid=46','VLFlash)

**For Law of conservation of energy (Newton’s Cradle):**

* <http://www.youtube.com/watch?v=jid7Nlzfet8>
* <http://www.youtube.com/watch?feature=player_detailpage&v=51RCyBr_nGk>